EXHIBIT 104

Pathology of Asbestos-Associated Diseases

Second Edition

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Some have argued that removal itself presents more of an exposure hazard than leaving the materials undisturbed or encapsulated.[16]

Measuring Exposure

Different techniques have been developed for measuring the concentration of asbestos in ambient air and in the workplace. The phase-contrast light microscope for counting fibers in the workplace has been less useful in the ambient environment, where fiber identity and character are usually unknown, fibers are too small to be seen by light microscopy, and concentrations expressed as mass are usually hundreds or thousands of times lower than those in the workplace.

Fiber concentrations in the workplace have generally been measured as the number of fibers longer than 5 microns. Ambient concentrations are now determined by transmission electron microscopy and usually are expressed as mass per unit volume (nanogram per cubic meter). Because of intrinsic variability in the unit weight of individual fibers, the conversion factors relating mass concentration to optical fiber concentration range from 5 to $150 \mu g/m^3/f/ml$. These conversion factors have been adopted by the EPA[15] and other scientific bodies.

Measurements acquired through transmission electron microscopy have established background concentrations of asbestos in urban ambient air at generally less than 1 nanogram per cubic meter (0.00003 fibers per ml) and rarely more than 10 nanograms per cubic meter (0.00033 fibers per ml).[17] Table 2-1 summarizes fiber concentration data from a variety of studies in both urban and rural areas.

Asbestos concentrations in buildings, on the other hand, are more variable, revealing threefold variability among arithmetic mean concentrations.[17] Earlier studies often focused on buildings in which asbestos surface materials were visibly damaged and friable, which were not representative. In buildings with evidence of severe damage or deterioration, the probability of detecting excessive asbestos levels

Table 2-1. Summary of asbestos exposure samples in different environments

Sample set	Sample No.	Measured concentration (ng/m^3)		Equivalent concentration (fibers/cc)*	
		Median	90^{th} %ile	Median	90^{th} %ile
Air of 48 U.S. cities	187	1.6	6.8	0.00005	0.00023
Air in U.S. school rooms without asbestos	31	16.3	72.7	0.00054	0.00242
Air in Paris bldgs with asbestos surfaces	135	1.8	32.2	0.00006	0.00107
Air in U.S. bldgs with cementitious asbestos	28	7.9	19.1	0.00026	0.00064
Air in U.S. bldgs with friable asbestos	54	19.2	96.2	0.00064	0.00321

Source: Modified from Ref.17. *Based on conversion factor of $30 \mu g/m^3 = 1$ fiber/cc.

Table 2-2. Summary statistics for average airborne fiber concentrations in U.S. schools and buildings

Statistic	Schools (71)	Outdoor air (48)	Public buildings Category 1 (6)	Public buildings Category 2 (6)	Public buildings Category 3 (37)
Median		0.00000	0.00010	0.00040	0.00058
Mean	0.00024*	0.00039	0.00099	0.00059	0.00073
Standard Deviation	0.00053	0.00096	0.00198	0.00052	0.00072

Source: From Ref. 18, with permission.

*80th percentile = 0.00045; 90th percentile = 0.00083.

The data used in the calculation of each statistic are the average concentrations (expressed as number of fibers greater than 5 μm in length per cubic centimeter of air) in a building (for indoor samples) or the concentration outside each building (for outdoor samples). By visual inspection, category 1 buildings contained no asbestos-containing material (ACM), category 2 buildings contained ACM in primarily good condition, and buildings in category 3 showed at least one area of significantly damaged ACM. In the study on public buildings, 387 indoor and 48 outdoor air samples were evaluated. No asbestos fibers were detected in 83% of the 387 samples. The sample size is given in parentheses below each heading.

over background was high. If the asbestos-containing surface materials or thermal insulation was undamaged or encapsulated, lower air concentrations were observed.

Table 2-2 shows summary statistics for average airborne fiber concentrations near schools and buildings Levels are comparable to outdoor air and are several orders of magnitude lower than current workplace standards (OSHA permissible exposure level (PEL) of 0.1 fibers per ml).

Asbestos abatement work is a significant potential source of asbestos exposure, particularly in schools and public buildings. While abatement procedures already specified by the EPA should minimize building contamination following renovation, removal, enclosure, or encapsulation of asbestos materials, these procedures may be violated.

The EPA has monitored the efficacy of the specified controls and cleanup procedures. Table 2-3 presents the results of one study of five schools where removal and encapsulation of asbestos-containing surfaces followed EPA procedures.[17] Although escape of asbestos fibers did occur during encapsulation and removal, there appeared to be a net reduction in fiber levels after encapsulation. Little improvement occurred in asbestos fiber levels following physical removal, with pre- and postabatement fiber levels being virtually the same. These results have brought into question both the health risk/benefit and the cost-benefit considerations of removal versus encapsulation. Currently, widespread removal of asbestos is not frequently recommended, and encapsulation is preferred in many situations.

Table 2-3. Geometric mean of chrysotile fiber and mass concentrations before, during, and after asbestos abatement

	Concentration							
	Before abatement		During abatement*		Immediately after abatement		After school resumed	
Sampling location	(f/l)†	(ng/m³)	(f/l)	(ng/m³)	(f/l)	(ng/m³)	(f/l)	(ng/m³)
Encapsulation								
Rooms with unpainted asbestos	1423.6	6.7	117.2	0.6	13.7	0.1	248.1	1.2
Rooms with painted asbestos	622.9	2.7	—	—	0.8	0.0	187.2	0.8
Asbestos-free rooms	250.6	1.2	0.5	0.0	9.3	0.0	30.7	0.2
Outdoors	3.5	0.0	0.0	0.0	6.5	0.0	2.8	0.0
Removal								
Rooms with asbestos	31.2	0.2	1736.0	14.4	5.6	0.1	23.9	0.2
Asbestos-free rooms	6.1	0.1	12.0	0.1	1.6	0.0	18.1	0.1
Outdoors	12.6	0.1	1.3	0.0	20.0	0.1	7.9	0.0

Source: Reprinted from Ref. 17, with permission.
*Measured outside work containment areas.
†Fibers of all lengths.

Regulatory Activity

Public health concern over the occupational and nonoccupational sources of asbestos exposure has created a vast array of governmental regulatory activity and the phasing out of asbestos production and its use in consumer products. This marked reduction in use is the result of regulatory activities in the 1970s and 1980s, during which time five government agencies invoked statutory authority to regulate asbestos.

The Occupational Safety and Health Administration (OSHA) regulates workplace exposure to asbestos and has set a PEL (an 8-hour time-weighted average for a 40-hour-per-week work shift) for occupational exposures. The PEL has been steadily lowered, as concern over health hazards and better monitoring methods have become established (Table 2-4). The first permanent standard, set in 1972, was 5 fibers/ml. This was lowered in 1976 to 2 fibers/ml and in 1986 to the lowest agreed to be technologically feasible at that time, 0.2 fibers/ml. The National Institute for Occupational Safety and Health (NIOSH) recommended a PEL of 0.1 fibers/ml, and this was also proposed as a regulatory standard by OSHA in 1990 and adopted in 1993.

The Mine Safety and Health Administration regulates the mining and milling of asbestos ore. The Food & Drug Administration (FDA) is responsible for regulating asbestos in food, drugs, and cosmetics. Consumer product bans on the use of asbestos in garments, dry-wall patching compounds, and fireplace-emberizing materials have been implemented by the Consumer Product Safety Commission. Despite these selected events, most of the regulatory activity has emanated from the Environmental Protection Agency.